THE EFFECTS OF BIOLOGICAL DECONTAMINATION ON THE RECOVERY OF CRITICAL FORENSIC EVIDENCE

by

Rebecca Jane Hoile

A thesis

submitted as requirement for the

degree of Doctor of Philosophy (Science)

University of Technology, Sydney

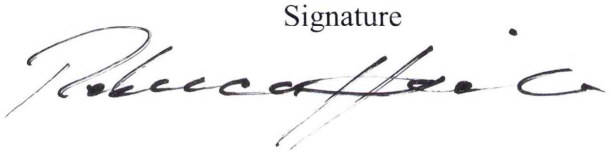
Faculty of Science

Certificate of Authorship and Originality

I certify that the work in this thesis has not previously been submitted for a degree nor has it been submitted as part of requirements for a degree except as fully acknowledged within the text.

I also certify that the thesis has been written by me. Any help that I have received in my research work and the preparation of the thesis itself has been acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

Signature



Date

14th July 2010.

Acknowledgements

The completion of this thesis has been through the input and support of a number of people. Firstly to my supervisor Professor Claude Roux, thankyou for your belief in my research. As the world of terrorism has opened up new and exciting fields in forensic science, your guidance and advice has been much appreciated. To my external supervisor, Dr. Simon J. Walsh for your assistance in helping me edit two published papers from this research. Your input was invaluable.

I would also like to thank my colleagues who have given kind support where needed and input where necessary, with special mention to Mr. Mike Colella. I thankyou for your shared passion in national security and counter terrorism preparedness. Your interest and support of this work has allowed me to conduct a large section of this project and I thank you for that. Furthermore, your assistance with editing this document has saved many an argument so I thankyou for your expertise in computer software.

I am fortunate to have friends and colleagues abroad with a wealth of knowledge in this evolving field, I particularly thank my international colleagues from the INTERPOL Bioterrorism Preplanning and Prevention Working group, for sharing valuable conversations and information relating to this work.

Thankyou to my family and friends for their understanding and continued encouragement, thankyou to those that have assisted with editing and formatting.

Finally, to Richard, the completion of this work would not be possible without your unending love, support and belief in capabilities that even I did not dare to dream were possible.

Work published as a result of this research

1) Hoile, R., Walsh, S. J., Roux, C. 2007, 'Bioterrorism: Processing contaminated evidence, the effects of formaldehyde gas on the recovery of latent fingermarks.' *J Forensic Sci*. 52(5):1097-1102.

2) Hoile, R., Banos, C., Colella, M., Walsh, J, S., Roux, C. 2010, 'Gamma Irradiation as a Biological Decontaminant and its Effects on Common Fingermark Detection Techniques and DNA Profiling'. *J Forensic Sci*. 55(1):171-177.

3) Hoile, R. *et al.* 'The Effects of Biological Decontamination on the Recovery of Latent Fingermarks.' International Fingerprint Research Meeting. Canberra. 2007.

4) Hoile, R. *et al.* 'The Recovery of Forensic Evidence Using Gamma Irradiation as a Biological Decontaminant.' Australian New Zealand Forensic Science Society Conference. Melbourne. 2008.

Table of Contents

List of Tables

List of Figures

Abstract

The principle objectives of this research were: (i) to investigate gamma irradiation and formaldehyde gas as successful decontamination options for the destruction of bacterial spores; (ii) determine their impact, within the context of a biological crime, on the recovery of selected evidence types; and (iii) develop triage systems for contaminated evidence.

Substrates including paper, plastic, glass, electronic devices and firearms were contaminated with viable bacterial spores, and subjected to the decontamination methods developed. The effects of these methods were tested by comparing evidence recovered both pre and post decontamination. Evidence types recovered included; latent fingermarks, DNA, electronic data and firearm related toolmarks.

An exposure range of between 40-90 minutes for formaldehyde gas was determined effective compared to the standard 12-hour, laboratory based procedure. Experiments determined a detrimental interaction between formaldehyde gas and amino acids, with a reduction in recovery rates for latent fingermarks and DNA from porous items. Formaldehyde did not however affect the recovery of electronic data or firearm markings. Based on the collective results formaldehyde gas decontamination is recommended for use on non-porous items such as glass, plastic and metal, with emphasis on electronics and weaponry, yet would not be recommended for use as a primary decontaminant for porous items or items where DNA evidence is required.

Test items were also subjected to a range of gamma doses to determine the effective kill curves based on log reductions. Successful decontamination was achieved between 5-10 kGy, depending on the sample type. Gamma irradiation did not affect the recovery of latent fingermarks, firearm comparisons or DNA from paper. Significant damage to electronic devices was observed at the levels required for bacterial spore death; therefore, gamma irradiation is not recommended where data is the primary evidentiary concern.

This research has explored the notion that no one biological decontamination option is suitable for all substrates or all evidence types. It has demonstrated, through the development and validation of specific decontamination methods, that both formaldehyde gas and gamma irradiation can be applied successfully to certain substrates prior to recovering forensic evidence.

The ability to recover vital evidence from the scene of a biologically contaminated crime scene, be it through an act of terrorism or inadvertent release, is a valuable tool to the forensic analyst and an emerging concept in the field of forensic microbiology.